

lished by plural electrostatic diaphragms in an array that is disposed on top of the pressure array shown in FIGS. 4-6.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Referring initially to FIG. 1, a system is shown, generally designated 10, that includes a TV remote control 12 with a housing 14 that bears a wireless transmitter 16 such as an infrared or radiofrequency transmitter for transmitting commands such as channel up/down, volume up/down, and the like to a TV system 18 having a wireless receiver 20. The remote control housing 14 also bears a remote processor 22 that can access a tangible computer-readable medium 24 that may store code executable by the processor 22 for undertaking logic disclosed herein. The medium 24 may be, without limitation, solid state memory, disk-based memory, or other appropriate memory, permanently housed in the remote control 12 or removably engaged therewith. The remote control housing 14 can also support a visual display 26 and a touch surface 28 in accordance with present principles. The touch surface may be made of a touch pad material and may be a planar sheet of material that overlays the structure described below. As shown, the touch surface 28 may be a single button-sized input element that operates in accordance with disclosure below to provide cursor and entry input to the processor 22, which can control the display 26 in response.

[0022] The TV system 18 may also have a TV processor 30 that can access a TV computer readable medium 32 to control a TV display 34 and a TV tuner 36 in response to signals sent from the receiver 20. The TV processor 30, in addition to or in cooperation with the remote processor 22, can execute logic herein, all or parts of which may be stored on the TV medium 32. In some implementations the TV system 18 may also include a wide area computer network interface 38 for receiving audio-video streams from, e.g., the Internet. It is to be understood that the components of the TV system 18 may be supported in a TV chassis, or some of the components may be supported in a separately housed set-top box or other receiver that is electrically connected to the TV processor 30.

[0023] As shown, the TV display 34 can present an image 40 of a notional keypad with plural keys 42. In addition or alternatively, the image 40 can be presented on the remote display 26. As described further below, while only a single key-like touch surface 28 need be provided on the remote control 12, slight motion of a person's finger on the touch surface 28 as by pressing in a direction of intended cursor motion can result in the image 40 changing (e.g., by moving a screen cursor) to indicate emulated finger motion over plural notional keys 42, and this visual feedback of simulated motion is accompanied by coordinated haptic feedback representing finger motion over discrete mechanical key structure and generated through the touch surface 28 as described further below.

[0024] While one embodiment contemplates a TV remote control application as shown in FIG. 1, as shown in FIG. 2 a touch surface 28a in accordance with present principles may be provided on a computer 50 such as a notebook computer with input keyboard 52, processor 54, and computer readable medium 56. The processor 54 can display images on a monitor 58 in accordance with present principles.

[0025] Furthermore, as shown in FIG. 3 a touch surface 28b in accordance with present principles may be provided on a wireless telephone 60 with wireless telephony transceiver 62,

processor 64, and computer readable medium 66. The processor 64 can display images on a display 68 in accordance with present principles.

[0026] FIGS. 4-8 show non-limiting details of one embodiment of the touch surface 28 using the embodiment of FIG. 1 as an example, it being understood that the touch surface embodiments of FIGS. 2 and 3 are configured and function similarly. An array 70 of pressure sensors 72 such as, e.g., force sensing resistors (FSR) or other appropriate pressure sensor may be supported on a substrate 74 such as a circuit board in the remote control housing 14. The array 70 lies directly beneath the touch surface 28, with the below-described haptic membrane assembly intervening but still transmitting pressure from the surface of the touch surface 28 to the array 70. While an array of plural sensors 72 is shown, an array of a single sensor that can detect motion in accordance with principles herein may be used.

[0027] As shown in FIG. 5, finger pressure, illustrated as a circle 76, may be transmitted through the touch surface 28 to the array 70. When a person moves the finger slightly as by slightly rolling it or, from another point of view, by pressing in an x-y direction on the touch surface without sliding the skin on the touch surface, the varying signals from the sensors 72 are sent to the processor 22, which derives a direction of finger motion represented by a vector 78 as shown in FIG. 6. This can be done relatively simply, e.g., in the example shown in FIG. 6, increasing pressure on the upper right sensor 72 of the array 70 indicates motion to the upper right as indicated by the vector. The magnitude of the vector may be determined based on the rapidity of pressure change in the x-y plane, with faster change indicating greater magnitude, or on magnitude of pressure in the z-dimension, with greater pressure indicating greater vector magnitude. Some combination of these may be used.

[0028] Once the vector of finger pressure motion is established, a cursor on the remote display 26 and/or the TV display 34 is caused to move relative to the image 40 of notional keys, in effect causing the image to change. Cursor motion is in the direction of the vector and may proceed at one speed on the display or at a speed that is proportional to the magnitude of the vector. Cursor motion may proceed, for instance, as long as finger pressure is sensed on the touch surface 28. In this way, the user is presented with visual feedback of emulated finger motion on the notional keypad in response to the sensed changing pressure. As intended herein, the visual feedback is keyed to haptic feedback.

[0029] Accordingly and turning now to FIGS. 7 and 8 to understand how haptic feedback of cursor motion is generated, a haptic membrane assembly 80 is disposed directly under the touch surface 28 between the pressure sensors and touch surface. The assembly 80 can be inflatable and can be selectively inflated by the processor 22 in response to finger pressure on the touch surface as described in the following paragraphs.

[0030] As shown in FIG. 7, the membrane assembly 80 includes an array of individually inflatable fluid sacs 82. The sacs 82 may be inflated with air or other gas or with a liquid. Each sac 82 is associated with a respective electro-mechanical valve 84 the electrical portion of which is electrically connected to the processor 82 by preferably two crossing electrodes in a control matrix 86, such that each valve 84 is individually addressable to open or close to inflate and deflate